The Hungarian Technology Foresight Programme

PRODUCTION AND BUSINESS PROCESSES

Panel Report

BUDAPEST

2000

In 1998 the National Committee for Technological Development (OMFB) launched a technology foresight programme named TEP after its Hungarian acronym. The main objective of the programme was to make a contribution to improving the long-term competitiveness of the country's economy. This would enable new opportunities to be identified in the development of both the market and technology that would improve the quality of life of the population. By analysing major changes in the economy and society as well as new achievements in science and technology, TEP defines the key issues and the areas where strategic decisions need to be made that will be crucial for the country's development in the next 15-25 years.

The Steering Group and the thematic panels have assessed the current situation, outlined different scenarios for the future, and formulated their recommendations to implement the favoured approach.

The thematic panels analysed the key aspects of the following, closely interrelated areas:

- Human resources (education and employment)
- Health and life sciences
- Information technology, telecommunications and the media
- Protection and development of the natural and built environment
- Manufacturing and business processes
- Agribusiness and food industry
- Transport

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Introduction

The Hungarian economy has passed the most difficult stage of the stabilisation process. The principal institutional elements of the European market economies have been successfully integrated and as a result of these achievements, international confidence in the Hungarian economy has also been firmly established. The transition to a market economy has also largely been completed at company level. The first round of a 'natural selection' process has taken place in the area of business enterprises which was primarily determined by developments on foreign markets together with domestic social and institutional changes. In essence, only those companies that were able to adapt to international operating conditions and meet the demands posed by their new owners remained in business.

Owing to the extreme complexity of the topic, the Panel has been obliged to limit its studies to the following areas:

- New materials, components and tools;
- New processing and production technologies;
- Problems regarding the value-added processes (supply-production-sales chain);
- Management of organisations and modern organisational forms.

THE CURRENT SITUATION (A SNAPSHOT)

Macro-Economic Processes

In 1999 the Hungarian GDP amounted to 99.3 percent of its 1989 value. Therefore 1999 was the first year since the nadir of the recession in 1992-1993 in which economic performance in some way approached the levels achieved in the years prior to the change in the political system.

Table 1: GDP – volume indices for production and utilisation -1990 to 1999 (preceding year = 100)

Index	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
GDP production	96.7	88.1	96.9	99.4	102.9	101.5	101.3	104.6	104.9	104.5
Industry	92.4	82.2	93.3	104.4	105.9	107.0	103.3	111.4	108.9	108.2
Agriculture	95.4	91.9	83.4	92.1	99.6	102.7	104.2	99.5	98.5	98.7
Personal consumption	96.4	94.4	100.0	101.9	99.8	92.9	96.9	102.0	104.9	105.1
Investments	92.9	89.6	97.4	102.0	112.5	95.7	106.3	108.5	112.7	106.6
Domestic use	96.9	90.9	96.4	109.9	102.2	96.9	100.8	103.8	107.8	104.2
Exports	95.9	95.1	102.1	89.9	113.7	113.4	107.4	129.9	122.5	113.2
Imports	94.8	105.5	100.2	120.2	108.8	99.3	105.7	126.4	124.9	112.3

Source: KSH (Hungarian Central Statistical Office)

The elimination of oversized, non-profitable production facilities in the industrial sector was a necessary exercise. At their lowest point in 1992, industrial sales were one-third lower than the levels of 1989. The manufacturing industry stabilised shortly after reaching its critical point and, after its recovery in 1992-1993, grew increasingly from 1994 onwards. The machinery industry weathered the crisis, the best reaching 1989 production levels as early as 1996 due to the radical restructuring activities in the sector and its focus on exports. Industry as a whole was only able to achieve this in 1998. A particular feature of the industrial restructuring process is the very high proportion of activities with high material costs within the production structure. This is due to the higher level of international cooperation as well as rising prices.

Total capital investment in the manufacturing industry was 628 billion forints in 1999 out of a total of 2,407 billion forints invested in the entire domestic economy. The relative importance of the manufacturing industry is even more significant if viewed in terms of gross national product. This sector contributed 7.4 thousand billion forints towards total GDP (20 thousand billion forints) in 1998. Between 1998 and 1999 production in the manufacturing industry rose by 12.4 percent, productivity by 11.1 percent, and sales by 13 percent.

With regard to *exports*, the 1990s may be divided into two distinct periods. During the first four years of the decade, export volumes fell by a total of 20 percent following the collapse of the former 'communist common market' (Council of Mutual Economic Assistance) and due to difficulties in adapting to western markets. Subsequently, between 1994 and 1998 export volumes experienced spectacular growth, achieving annual growth rates of around 18 percent on average, which by far exceeded the GDP growth rate[1]. The most rapid growth was seen in export volumes to the European Union, which rose from a level of one-third of total exports in 1990 to 76 percent in 1999. Some 70 percent of total exports are produced by multinationals active in the global economic processes.

Table 2: Exports by main product groups in 1999 (in billions of HUF)

Product Group	Exports	Exports to OECD	Exports to EU
Foodstuffs, beverages, tobacco	474.1	256.1	231.5
Raw materials	146.9	103.9	99.1
Fuels	96.3	65.9	65.4
Processed goods	1 819.8	1 415.1	1 274.9
Machinery, transport equipment	3 401.4	3 137.5	2 855.6
Total	**5 938.5**[2]	**4 978.5**	**4 526.5**

Source: KSH

The *number of companies* operating in Hungary in terms of the size of the population (7.8 businesses per 100 people) corresponds roughly to the western European average.

[1] The growth of exports from the machinery industry is particularly impressive: the figure rose by over 150 percent in four years.

[2] Within this total amount, the value of 'work contracted out' is ca. HUF 1.2 billion.

However, in Hungary, a large proportion of these business enterprises were only set up for tax reasons, or out of necessity, so their conduct resembles more that of an average employee than that of an entrepreneur.

The share of *private ownership* within the economy increased from 10 percent in 1990 to nearly 90 percent by the end of 1999 with a similar shift taking place in the composition of the GDP. The *ratio of foreign ownership* in the shareholder structure of corporations was over 50 percent in 1999. At the same time, a relatively limited number of Hungarians hold a direct share in the 230 thousand or so companies, with around 43 to 44 thousand individuals owning shares. Privatisation played a large part in transforming the ownership structures of Hungarian business and was responsible for around 43 percent of the process, while 31 percent was attributable to 'greenfield' investment projects. Foreign portfolio investors followed the foreign direct investors onto the Hungarian market and they now control about three-quarters of the capital on the Budapest Stock Exchange.

Attracting foreign capital to the country has been one of the great success stories of the past decade. An amount of USD 20.2 billion in direct capital had entered the country by 1999, which is the highest amount in per capita terms of all the ex-communist countries. *Investment in Hungary accounted for a third of all direct capital invested in the region in the 1990s*. Out of the 50 largest multinational companies, 40 are represented on the Hungarian market. At the end of 1998, 37.2 percent of the assets of all the companies operating in Hungary and filing corporate tax returns were in foreign ownership. The proportion of companies with foreign capital was 12 percent; in terms of their registered capital, however, these companies controlled 48 percent of all Hungarian business assets. The level of foreign capital differs from sector to sector. The highest levels are found in the manufacturing industry (59.7 percent) and the financial sector (57.1 percent) and the lowest in agriculture (7.5 percent). The manufacturing industry had the highest level of FDI (37.9 percent of total imported capital) and there is practically no foreign investment in education (0 percent), health and social services (0.1 percent) and mining (0.4 percent).

Foreign-owned companies also have an important indirect influence on the development of the Hungarian economy. Evidence shows a p*ositive effect on productivity* in the case of Hungarian firms that have joined *international networks*. Whether success is measured in terms of export performance or successful competition against imports, the companies on the honours list include a significant number of component suppliers to multinationals.

During the period between 1990 and 1996 *employment figures fell* continuously and finally plunged to 4 million, a total decrease of nearly 30 percent (1.5 million people). Two-thirds of this decrease took place in the first three years. Since 1996, however, statistical records have recorded a slight annual growth in employment figures (less than one percent). There has been a radical drop in the number of employees in the competitive sphere, which operates under market conditions, whilst the number of employees in the public sector has fallen only slightly.

Despite Hungary's small size, large *regional* differences are apparent in its

development. The central region—and particularly the capital city—plays a predominant role and continues to grow. Per capita GDP in Budapest was 80 percent higher than the national average in 1994, 86 percent higher in 1998, and about one-third of the country's GDP was generated in the capital. During the first half of the 1990s, when the great structural changes were taking place in the economy, almost every positive economic development benefited the capital and the western and central Transdanubian regions, whilst Northern Hungary's situation deteriorated still more as a result of the negative changes. However, every region has seen some improvement in conditions in the latter half of the decade.

A major contributory factor to regional inequalities may be the differences in the *transport infrastructure*. The central and western parts of the country enjoy clear advantages in respect of the inter-regional transport opportunities and their accessibility from western Europe. Reductions in transport costs have also been easier to achieve in these regions as the major road-construction programmes, which began in the 1980s and continued in the 1990s, have for the most part been concentrated here.

The development prospects of the different regions are not only changing in terms of economic indices. The degree of urbanisation, the standard of medical services, the availability of education and the potential for research and development also have a major influence on the development opportunities of a given region. The number of students receiving higher education is surprisingly evenly balanced due primarily to the fact that there is a concentration of universities and colleges in the regional centres of the less developed areas (Debrecen, Miskolc, Pécs, Szeged).

The economic crises and the transition to a market economy have had a strong effect on *R&D activities* in respect of the operation and funding of the organisations involved in this sector, the number of people employed and the research topics selected. R&D expenditure was also cut during the stabilisation years, both by the state and by the private sector, which was struggling to overcome the crises.

The commercial research and development groups were dissolved following the disappearance of many of the large industrial firms. After privatisation, a number of companies discontinued direct R&D activities. Most of the newly created enterprises are relatively small and lack the financial strength either to support their own R&D organisations or even to contract out R&D work. The financial resources available for R&D continued to shrink. The lack of orders from the business sector and the cuts (in real value) in state support seriously weakened the different research sites in equal measures.

Table 3: R&D expenditure (relative to GDP)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Expenditure as percentage of GDP	1.61	1.09	1.08	1.00	0.93	0.75	0.68	0.74	0.70	0.68

Source: KSH

However, some favourable developments were taking place in the R&D sector at the same time as the cuts in the financial support. Opportunities for Hungarian participation

in international research activities have broadened significantly. The number of scientific articles published in collaboration with foreign co-authors, comprising 50 percent of all such publications, had increased threefold by 1995 in comparison with the early 1980s.[3]

Transformation of the Hungarian Economy and Hungarian Business Enterprises: Micro-Economic Processes

Rapid changes took place in the 1990s both in the market and the institutional environment. One result of this is that companies are experiencing a great deal of uncertainty, particularly in respect of economic policy. Furthermore, uncertainty generally constitutes an obstacle to strategic planning.

Substantial progress has been made in Hungary in respect of most aspects of corporate operations. An assessment of the trends amongst those companies adapting to change shows the following:

- successful *adaptation* (there are more advanced products, production processes, organisational principles and methods, companies are rebuilding their contact networks, elements of the value-added processes are being restructured);
- *major enterprises* are successfully catching up (certain growth industries are experiencing rapid reorganisation or technological change /e.g., the plastics industry/ whilst in some stagnating sectors companies are moving towards a higher-quality product range /e.g., the iron and steel industry/).

The arrival of multinational companies and their operations have given the economy a significant boost. These companies have played a key role in putting high-quality goods on the Hungarian market and have also generated certain processes (improved technological and organisational processes, establishment of suppliers' networks, etc.) in the Hungarian economy, the effects of which may constitute the basis for increased competitiveness of Hungarian companies in the medium and long term.

A recent development dating from the late 1990s are the investments made by Hungarian companies abroad, especially on the eastern markets. These investments are still modest in volume but may yet prove to be an important basis for corporate expansion in the medium term.

There is universal agreement amongst economic forecasts that the small- and medium-sized enterprises (SMEs) will play a key role in the coming years. Hungary's situation in this regard is in some respects very similar to that of the other EU countries, but there are also certain differences. The main similarities and differences are as follows:

- There is no real difference in the respective proportions of enterprises according to size.
- According to estimates, SMEs employ some two-thirds of all wage earners in Hungary. (This figure is close to the EU average, but lower than the corresponding figure for the Southern European countries.)

[3] During the decade, Hungary has become integrated into the common system of the major European R&D institutes (EUREKA, COST, CERN, EU and NATO R&D programmes).

- SMEs produce just over half of GDP. (In the EU the contribution of SMEs to GDP is also less than their contribution to employment.)
- As regards their distribution among the different economic sectors, domestic data to a great extent resembles EU data. (For instance, the figure of 13 percent in respect of industrial activities is the same in both cases.)
- In terms of sales income/enterprise, the Hungarian figure is only a fraction (between 20-30 percent) of the figure produced by the SME sector in the EU.

Due to the changes that have taken place in the structure of the economy, special attention should be paid to suppliers' networks. In the course of the past ten years, a large number of the world's top multinational companies have commenced operations in Hungary. In a short time, most of these concerns have built up modern manufacturing facilities, particularly in the machinery industry. It is a promising sign that, in the case of these enterprises, the first investment projects have almost always been followed by additional investments.

The volume of supplies directed to the multinational companies operating in Hungary reached a level of HUF 400 billion in 1998, which represents an increasing trend in comparison with previous years.[4] At the same time, studies show that the majority of the foreign-owned companies, which operate at very high technological standards and present a great potential market for suppliers, still work in relative isolation from the general business environment in Hungary.

A study of the *demand for supplies* shows that the majority of purchaser firms in Hungary operate in the automotive and electronics industries. The majority of these are suppliers themselves situated around the middle of the 'supply pyramid', but some are final assemblers and a few are integrator companies at the top level of the pyramid. For different reasons, the proportion of demand from companies in the Far East (for reasons of trade policy) and from Hungarian or partially Hungarian-owned companies (for reasons of ownership structure) is much higher than that from buyers executing greenfield site projects where demand is much lower than average.

The form of investment in Hungary has an effect on the acquiring company's relations to suppliers. In the case of multinationals acquiring *long-standing, traditional Hungarian companies outright, i.e., 100 percent,* the change in ownership does not automatically mean that previous Hungarian business partners are abandoned, although the expectations that suppliers must meet become the same as those at the parent company. A still greater degree of tolerance is shown to Hungarian suppliers and would-be suppliers in the case of companies with *foreign majority ownership*. On the other hand, in the case of multinationals coming to Hungary through *'greenfield' investment projects*, the product range offered in Hungary is the same as that produced by the parent company for a long period. Consequently: /1/ the manufacturing process is well-established, almost no development is effected in Hungary, and production consists principally in assembly work; /2/ there is a well-established, tried and tested group of (foreign) suppliers with a proven track record set during the earlier period of operations, making it much more difficult to break into the circle; /3/ the procurement of materials,

[4] The share of supplies from domestic companies to international companies exceeded 20 percent at the end of the decade.

parts, and components required for the day-to-day production is centrally controlled. The proportion of Hungarian suppliers in this group amounts to about ten percent. The only exception is the case of manufacturers from countries that have an interest in expanding their purchases in Hungary due to EU customs regulations. Here, the multinational companies try to persuade their regular foreign suppliers to set up production plants in Hungary. The international companies that became established in Hungary through greenfield investment projects—particularly the prime suppliers to the large multinational corporations—have recently started to look more and more for Hungarian suppliers. There are grounds to believe that the current low share of the supply market will grow if suppliers receive appropriate and consistent support. There is evidence that a price difference of around 10 to 15 percent is necessary to induce buyers to abandon their regular and reliable foreign supplier and change to a new one, all other commercial considerations, quality and reliability requirements being equal.

An examination of the *supply aspect* shows that there are about 700 to 800 businesses currently operating in Hungary, although not necessarily in Hungarian ownership, which may be considered as suppliers—mainly in the machinery, metal, plastics, and rubber industries. Approximately the same number of firms may be considered as potential suppliers, if appropriate incentives are provided and investment is spent on development. In Hungary, the principal means of encouraging development in this direction comprises improving the business environment of the participants in the support industries and boosting supply through assistance programmes.

Trade surveys show that at the end of the 1990s, nearly one-quarter of companies were active in *research and development activities*, and more than half of these launched substantial new products on the market. The greatest hindrances to innovation are the lack of finance resources, the weak innovation potential of the companies, poor management and the lack of qualified personnel. In 1999, most of the companies still failed to see any connection between commercial success and relations maintained with research institutes or universities. At the same time, case studies of enterprises with a successful innovative performance record prove that collaboration with scientific research institutes usually plays a significant role in commercial success.

Trends

The developments likely to occur over the next 15 to 20 years in the areas investigated by the Panel have a significant influence on the scenarios and therefore also on the direction most favoured by us. Any potential advances in these areas will be inextricably linked to these events.

The trends in the areas selected by the panel may be summarised as follows:

New materials, parts and equipment

- Goods will be made of an increasing variety of materials.
- The materials used will carry a greater information content.

- A given component will be incorporated into more and more types of products.
- Recycling will become more important.
- Biological processes will become an organic part of a number of technological processes.
- High-temperature super-conductors will be used in everyday industrial production.
- Composite materials will become more important both in structural and functional uses.
- The use of *polymers* with special electrical, magnetic, and physical properties will increase.
- Bio-compatible materials (polymer-, metal-, ceramic-based composites) will become increasingly and more important.
- Polymer gels will be generally used as special energy transformation systems.
- The development of *nanotechnologies* will bring about the 'industrial revolution' of the next 10 or 15 years.
- With regard to most types of sensors, the analogy with biological systems is the general direction to take. The aim is to create models which best approximate the sensorial mechanism and sensitivity of human sensory organs and those of other living organisms. The sensorial and optical application of semi-conductors will become more and more important.

New processing and manufacturing processes

- Growing importance of energy-saving industrial processes.
- Increasing discrete technological processes in the chemical industry.
- Introduction of technological processes facilitating the production and processing of biodegradable and recyclable materials.
- General application of processes with no waste.
- General use of new-generation, digitally controlled production equipment (with fewer pneumatic and hydraulic elements).
- General application of 'thin-layer' technologies.
- General use of computer-assisted modelling in product design.
- Spread of 'rapid prototyping' (direct manufacturing).
- Declining role of domestic aluminium production and related industrial technologies.
- Use of fuel cells to power road vehicles.
- Development of technologies related to renewable energy sources.
- Further growth in the range of processes based on biotechnology.
- Rapid growth of intelligent (computerised) measurement procedures and systems in the area of measurement technology.

Main development trends in the area of automated production[5]

- Development based on 'data mining' with the most modern tools of information technology enabling immense volumes of information to be searched and relevant connections and relationships to be identified.
- The role of the *time factor* will become even more important (competitive engineering, rapid and virtual prototyping, simulation).
- Along with mass and serial production, the production of one-of-a-kind products is becoming increasingly popular.
- The *globalisation* of design, production, and distribution will continue (world-wide participation and cooperation in production, production networks, logistics).
- The role of the *human factor* is being emphasised, partly in connection with the globalisation process (education, new organisational forms).
- The application of *artificial intelligence* technologies is increasing.

Issues related to the value-added processes (supply-production-sales chain)

Globalisation has emphasised the importance of the virtual enterprise. In these companies, production facilities do not operate within a single, well-defined plant site; they are often separated by huge distances, even continents. Virtual manufacturers supply products to many clients and their alliance was created in response to specific tasks. Information technology and logistics form the connecting link, i.e., the two driving forces in the world of the modern electronic economy where it is possible to plan, order, and monitor the flow of information, materials, parts, equipment, and assets in both time and space on a continuous basis.

The following trends appear to be realistic during the next 15 to 20 years:

- the Hungarian supplier sector will continue to grow and develop;
- information technology will become increasingly significant within the management of Hungarian industrial companies;
- from 2010 onwards at least half of Hungarian businesses will be operating on local markets whilst pursuing a strategy of international expansion;
- environmental protection regulations will become more stringent;
- environmentally friendly products, bearing special labels, will gain a growing share of the market.

[5] Whilst the processes in the field of automated production largely resemble the technological differences mentioned previously, it appears justified to highlight these in view of the importance of the topic.

Company strategy, management

- Company strategy, organisational structure, and information flow will become secondary to consumer requirements;
- Moral and ethical considerations will become important with regard to competition on a social level and also within the market.
- The effects of business decisions on the natural and social environment will receive more attention.
- Risk avoidance will be replaced by risk management.
- Participation in and delegation of tasks will play an increasingly important part in the area of management.
- The spatial mobility of managers will increase.
- Employee share-ownership will become increasingly important as an incentive and a means to increase employee commitment.
- The number of hierarchical levels within companies will decrease.
- The importance of team working will grow.

Human resources and workforce management

- Further training on an ongoing basis will be in the common interest of both the employer and the employee.
- On-the-job training and education will become more important within the general training system.
- It will become increasingly important to identify the areas of competence and the skills required to maintain the long-term competitiveness of a given organisation, involving the location, recruitment, retention and motivation of the individuals who possess these skills.
- It will become essential to integrate the resources possessed by separate individuals into complex, organisation-level entities—organisational culture, organisational knowledge, etc.
- The virtual workplace will assume a greater role.

Scenarios

Scenario 1 - ‘At the Forefront of the Followers’

This model is closely related to the TFP Steering Group’s macro vision 1, which is deemed to be the most favourable. This scenario sees Hungary integrating into the international economy and global society on the basis of mutual advantages. It sees Hungary as a partner with a definite strategy pursuing a course of highly knowledge-

intensive development, never losing sight of the quality of life of its people. The production and application of knowledge, the preservation of health, responsibility for the natural environment and the reinforcement of social cohesion and solidarity are the primary milestones to be achieved within this scenario.

During the next few decades, prudent changes to the regulatory environment, incentives and pressures from the European Union and the knock-on effects of the successful integration of Hungarian companies into Europe will enable the successful and organic integration of Hungarian industry into the market competition pursued by global enterprises within the processing industry.

A sector of viable small and medium-sized enterprises will have begun to develop by the time we accede to the European Union (anticipated in 2005). Investors looking for opportunities in the Hungarian manufacturing industry in 2020 will undoubtedly be able to rely on a range of small businesses operating in the major industrial sectors. These companies will be using fully computerised systems to organise and handle logistics, production, customer services, and will have by then become the most important contributors to the growth of Hungary's GDP. By 2020, the appropriate financial environment will also have developed and stabilised and will be in a position to assist Hungarian suppliers by consistently providing them with the capital they require.

This scenario anticipates a knowledge-intensive course of development. It assumes that research and development will become more closely linked to the field of competitive business both in respect of the selection of R&D topics and matters of organisation and financing.

The funding situation in the field of R&D will improve considerably. Closer cooperation will develop between business organisations and research institutes. By around 2008-2010, 40 to 50 percent of R&D costs will be financed directly by the private sector.

The state will provide incentives for R&D activities and at the same time aid the development of small and medium-size businesses by creating a simpler and more transparent regulatory environment, supporting research, establishing and developing information and knowledge networks and providing long-term, stable sources of finance.

As a result, the quantity of new materials, parts, and equipment used in the processing industry will rise along with the quality of the technological processes applied, and the organisational and managerial changes within the industry will continue in a positive direction.

Hungarian scientific research in the field of physical sciences (solid state physics, chemistry), based on the traditions of the past and also, hopefully, on improving international and domestic conditions, will by 2020 be making a significant contribution to modernising the product range, extending the use of high-tech industrial activities in certain areas and establishing innovative small- and medium-sized enterprises. All the above should result in a significant growth in GDP.

In the case of nanotechnology, Hungarian research will comprise follow-up work on primary research done elsewhere and this activity will provide the basis for training the specialists required by new industrial firms operating in the country. A number of small

and medium-sized firms will also come into being, mainly in the field of photonics. In respect of the corporate giants at the forefront of global competition, it may become industrial practice by 2020 to incorporate the achievements in the fields of information technology and computer science into materials ('intelligent' or 'smart' materials) and production processes. As Hungarian companies develop into increasingly more competent strategic partners for global business networks, they will have access to these technologies and become capable of adopting new developments. By the year 2020, special hybrid materials, composites, including special alloys of steel, ceramics and alu-plastics will be widely used and the producers of these materials will enjoy numerous opportunities on the automobile production, recycling, machinery industry and biotechnology markets. In the field of industrial materials, the production and use of synthetic materials that 'simulate' biological functions and are created in the pattern of living organisms will grow at a particularly rapid rate. Biotechnological methods will be generally applied in the raw materials industries. By 2015, the presence of special materials (titanium alloys and ceramics) that are compatible with human tissue will be widespread on the Hungarian market. As a result of global competition, waste-free manufacturing processes will generally be employed in the Hungarian industry by 2015-2020, bringing about a total change in technology. This change will be unavoidable due to the depletion of domestic resources; the costs of the changeover and the high degree of risk involved will, however, have the effect of postponing the implementation of the change for as long as possible. The increased application of thin-layer technologies is a key strategic area of the technological tooling and machining processes. These are having a significant impact on such key areas as the electronics industry and also on the technological methods used in optical and chemical fields. The domestic steel and machinery industry has already been made aware of the pressing demand for economical use of materials and energy, which has been dictated by competitors. In this respect these industries have realised that one of the most important strategic directions of their industry is towards '*direct manufacturing*', and '*rapid prototyping*', the latter having developed out of the former. The advantages of the rapid prototyping technology include the exceedingly low quantities of raw materials and other resources required and the very small amount of waste produced, making the technology particularly environmentally friendly. The technological changeover is not likely to occur before 2010 but may last until 2030. This change, along with the large-scale production of special steel alloys referred to earlier, will also bring about the re-location of less advanced technologies to more backward regions.

The opportunities for the Hungarian *chemical industry* are very favourable in respect of their ability to meet the big challenge of the next 10-15 years, namely the demand for an increased use of energy-saving processes. Thanks to the achievements of fundamental research conducted in Hungary, the particularly dangerous wastes produced in the course of manufacturing are being neutralised by means of thermic plasma processes. Discrete technological processes are becoming more widespread in the chemical industry. Our pharmaceutical companies and manufacturers of agricultural chemicals are integrated into international companies and their competitive positions are good.

Demand from multinational companies for parts and components is causing the development of a network of small and medium size suppliers. The supply requirements of these companies will increasingly be met by domestic suppliers.

The Hungarian economy, which is integrated into European competitive structures, will undergo organisational changes in the next three decades which will facilitate the adaptation of the Hungarian industry provided the present framework of the global market continues to exist. By the year 2020, the only domestic business organisations to survive will be those able to become part of a corporate network competing on the regional market, thereby proving themselves worthy of participation in strategic alliances. This process may only succeed if domestic companies are able to respond with flexibility to the continuously changing needs of networks that treat the design-production-sales system on an integrated basis. The adjustment requires efficient transport and sales systems. The primarily satellite-based navigation systems that form the basis of large logistics systems will be installed with government support during the early part of the period under review. This will make the country an attractive location for the large international business networks, consisting mainly of virtual enterprises, which wish to be able closely to track each phase of the supply-production-distribution process.

The next generation of Hungarian managers will be thoroughly versed in the completely mobile and flexible managerial culture of the multinational corporations. By the year 2015–2020, Hungarian firms will have *international management,* not only in the sense that the foreign owners bring personnel from their international organisations to Hungary and thereby import their own 'management know-how' to the country, but also the other way round, i.e., in the sense that *Hungarian managers will become part of the international management elite*.

On the basis of the pressure of competition for a *high-quality workforce*, the majority of Hungarian businesses will introduce organisational methods aimed at enhancing employee commitment by 2020, for example *working in teams* in a variety of forms. This process is slow by necessity and its widespread application may only be measured in terms of decades, as the objective of such organisational experiments is not primarily a greater efficiency but a greater degree of job satisfaction. 40 percent of wage earners will be able to work from home in the future or at least away from their place of employment. 50 percent of their pay will be performance-based and considerations of quality together with the performance given by the work group or the enterprise as a whole will also account for a major portion of their remuneration.

Scenario 2 - 'On the Fringes of the Periphery'

This model is based on the assumption that the main direction of global economic and social developments will remain unchanged until 2020. The future state of the world may be expressed as an 'extension' of the technological and business trends seen at present. The problems arising from this course of development will prove to be manageable during this period and will not impose any radical changes of direction on us.

According to this model, *Hungary's competitive position will have deteriorated considerably by 2020.* The course of domestic development will diverge from that being followed by the rest of the world. Which factors could bring about this version?

1. The European Union's global competitiveness deteriorates. In the more competitive regions of Europe, there are attempts to 'desert', to find the 'back doors' through which these regions may continue to intensify their relations with the 'first world' and prepare to break away from the countries which are falling behind. (EU Forward Studies Unit, "Scenario No. 5: Turbulent Neighbourhoods")

2. Hungary will be unable to hitch its wagon to the train of global competition by 2020. Due to the effects of unexpected turns in domestic politics or potential negative events which affect our entire region, our integration efforts founder, our earlier achievements become merely a matter of form and our country, or perhaps the entire region, is 'placed on hold'.

In this scenario, most of the trends appear primarily to be major external developments to which we must adapt rather than potential points for breakthrough. The Hungarian economy's involvement in global processes is such that the effects of the negative trends are largely reinforced. Consequently, we must expect a reduction in our market opportunities as suppliers. Hungarian small and medium-size businesses are also unsuccessful in meeting the requirements of the investors emerging on the Hungarian market. The long-term effect of this is the inability of small- and medium-sized enterprises to gain access to the results of R&D work and their inability to participate in domestic development activities. The unhealthy structure of small and medium-size companies becomes even more rigid. Even decades from now the majority of small enterprises will still only be active on the personal services market, which is not particularly favourable for the purposes of the GDP. Furthermore, small firms acting as suppliers to large companies will mainly perform outsourced assembly tasks.

With respect to our large corporations, only those that are able to meet the demands for a continuous reduction of costs, stemming from the expectations of *cheap raw materials and cheap labour*, will survive.

Scenario 3 - 'Global Crisis'

The basic assumption of this model is that the *main direction of global economic and social developments will change fundamentally by 2020*. The international centres of business and political power accept the view that the current direction can no longer be sustained due to its untenable economic, social, and ecological effects. A proliferation of local catastrophes with global effects and threats of escalating, intensive, local armed conflicts are recognised as warning signs of pent-up tensions, forcing participants in global competition to take concerted measures.

The centres of power in the global organisation of economic and political activities shift. International centres of decision-making, reorganised in the interest of common survival, determine that the world of international finance is the principal source of the problem and thereby the obstacle to the crucial change in direction. This decision is made on the basis of the speculation on a global scale and the ruthless competition between global-sized corporate networks no longer under the legitimate control of nation-states and international organisations. It therefore becomes a key issue to create

appropriate counterbalances of power to gain worldwide control of the operations of the above organisations and to introduce international economic and legal regulations capable of preventing the long-term re-establishment of the organisations and restricted activities.

The result of this transformation will be that by 2020 *economic activity* on the planet will for the most part become the domain of organisations fulfilling *local requirements under the strict control of local communities*, while international communication and consultation structures will be maintained and even perfected. The international exchange of activities will only continue in such fields where it is inevitable, and then only in such forms as are compatible with the fundamental interests of survival. *Communication* will be the main focus rather than *transport.* Investment activity centred around trade and global efficiency considerations will decline and only the *market for knowledge* may be exempt from the general reduction of activity.

Hungary will be a definite loser in this scenario. By the time it will have managed to join the European Union and profit from the anticipated advantages of that integration, it would have to bear a disproportionately large share of the burdens of the radical cutbacks due to its modest political and economic significance. The previously existing structures of education and scientific research will also fall victim to the changes.

RECOMMENDATIONS

The aim of the recommendations is to define the key areas that may play a prominent role in implementing the most favourable and realistic scenario.

1. An alliance between the government and the companies in the interest of promoting *innovation*. A national system of innovation needs to be set up which goes beyond giving financial assistance to the development of technology. It should provide regular and accessible advice on questions of organisation and methods to all interested parties through the operation of a nationwide network.
2. For the purposes of advancing innovation, the government should give priority to the following areas:

- Inter-disciplinary research, support to technologies in the process of wide-scale adoption and to the so-called ‘transfer’ knowledge and activities;
- Attractive working conditions and salaries for persons working in the state R&D sector;
- Promotion of collaboration between research units working under the Academy, the universities and businesses leading to the creation of so-called ‘knowledge networks’;
- By analogy to the virtual enterprise, development of virtual research institutes and laboratories, i.e., research units linked by information technology, logistical infrastructures and placed under central direction;
- Incentives to multinational companies to establish and develop R&D capacities in Hungary;

- Improvement of growth opportunities for innovative SMEs by developing capital markets;
- Considered and thoughtful government procurement policy in the interest of boosting demand for technology-intensive products (e.g., education, health care, military, etc.).

3. Expenditure related to human resources should increasingly be considered as an investment rather than as a cost by the organisations concerned. New approaches are needed if the management of human resources is to contribute to long-term competitiveness. In order to allow businesses with a firm commitment to competitiveness to make efficient use of these systems, research should be carried out on these new methods, which are not yet very well known in Hungary, and the results should be included as soon as possible in the curricula of post-secondary schools providing education in business and the economy.

4. Both the new materials and the new technologies represent a serious challenge to our *education system*. The areas of the industrial and service sectors which employ information technology on a broad scale and carry out a greater proportion of value-added activities require employees who have been trained in an education system which emphasises innovation, creativity, team work, precision and ethical conduct as fundamental values. The need for rapid adjustment to change demands widely qualified professionals even at the lowest levels of the production hierarchy. As the effects of changes in the education system do not become apparent in the short term, but rather in the medium or even the long term, it is imperative that the basis of an educational structure in line with the trends described above is established as soon as possible.

5. The results of the present foresight study programme (and all other research concerning the economic and social conditions of the future) should be fed back into higher education as soon as possible. This requires direct financial support to the selected areas. In the field of education policy, the importance of developing and expanding post-graduate training must definitely be emphasised.

6. To reduce *regional differences,* direct economic measures should be taken to develop less advanced areas and the educational, research, and communications infrastructures should also be improved.

7. To *help suppliers*, various mutually beneficial networks should be established between the different economic participants. An information infrastructure must be created for the use of potential suppliers. The creation and development of the means and resources capable of taking financial risks may also contribute to the expansion of the number of domestic suppliers.

8. By now it has become evident that the rigidity of production processes, which has been growing with the increasing degree of automation, must be countered and the flexibility of production must be enhanced in every respect. All the business processes within a company may receive a great impetus from the flexibility offered by *information networks* and from cutting costs as a result of numerous factors. This is particularly important in the case of enterprises operating at several different sites.

Professional associations and chambers of commerce must take an active part in the collection and evaluation of relevant information.

9. Potential suppliers must continuously strengthen and develop their supply contacts, with the help of local trade and professional associations, and by preparing and submitting competitive bids and offers. For the same purpose:

- A technological centre (or more than one) should be created to assist suppliers or would-be suppliers in dealing with technical challenges, financed partly from business and partly from government funds;
- In the interests of strengthening the domestic supply sector, further incentives should be offered to medium or large Hungarian companies to take on the role of integrators and the government programmes in this regard must continue;
- Current lending methods are not suitable for solving the problem presented by the shortage of development funds. This area is much better served by the activities of venture-capital companies where the investments required to become suppliers may be covered by state guarantees;
- In an economy undergoing increasing globalisation, transport (logistics) and IT infrastructures constitute the basis for any development. The rapid installation and development of systems to support the logistical operations of navigation and tracking systems are indispensable to modern supply networks.

10. With regard to physical research, the crucial issue today is the requirement to adapt to the environment, which entails revising the research of this type conducted in Hungary. As biological processes are becoming incorporated into many technologies, we should seize the opportunity to participate in international research and development concerning molecular synthesis. The following areas should be prioritised.

- With regard to the development of new materials and related technologies to be included in the manufacturing processes, we should continue to examine and simulate materials and processes which occur freely in nature;
- The application of lightweight, high-strength, fibre-reinforced composites in the automotive industry is rapidly spreading.
- Our participation in cooperative research projects on polymers with special electric, magnetic, and mechanical properties must be increased since they may offer us valuable development opportunities;
- We should develop bio-polymers and other bio-compatible materials, produced through the combination of various biological and synthetic materials and required for surgical implantation and prostheses, together with high-efficiency, selective catalysts which are of central importance to the chemical industry;
- With regard to both research and higher-education, special attention should be paid to the appearance of totally new materials and tools in the field of photonics which offer a typically knowledge-based, development-intensive market for suppliers as part of the emergence of an entirely new industry.

11. Great importance must be attached to the treatment of waste, which will emerge as an industry in its own right in Hungary. One interesting and very promising part of

the ‘waste industry’ exists in disassembly operations. The accumulation of broken, worn-out, inoperative products and specific equipment must be taken apart and sorted by qualified personnel and this activity requires training in the field of physical sciences as well as technology. With regard to the waste-treatment process as a whole, information, communication and logistics all play a key role. The operation of end-of-life databases is indispensable.